APPLICATION TRANSMITTAL

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Julie L. Reed — 2/28/00
Julie L. Reed, Reg. No. 35,349 — Date

Dear Sir,

Transmitted herewith is the below-titled patent application.

Inventors: Crinon, Regis

Title: **SYSTEM TARGET DECODING WITH SECONDARY MULTIPLEXING**

Attorney Docket No.: SLA0207

No. of pages/sheets:

Application: 15 Informal Drawings: 3

Oath and Declaration: 1

The fee is calculated as follows:

Independent claims	Total claims	Fee
2 – 3 included = 0 extra	6 – 20 included = 0 extra	$690.00

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This form is submitted in triplicate.

Respectfully submitted,

Sharp Laboratories, Incorporated
5750 NW Pacific Rim Blvd.
Camas, WA 98607
(360)817-7651

Julie L. Reed
Reg. No. 35,349

SYSTEM TARGET DECODER WITH SECONDARY MULTIPLEXING

BACKGROUND OF THE INVENTION

This application is a continuation of US Provisional Patent Application No. 60/134,580, filed May 17, 1999, and claims priority thereto.

1. Field of the Invention

This invention relates to systems with coded information transported to the receiver, more particularly to those using MPEG (Moving Pictures Experts Group) transport streams.

2. Background of the Invention

The MPEG standards comprise a group of standards used in transporting information to an audiovisual system receiver, the coding of that information on the transmission end and the decoding of that information on the receiving end. The transmitter multiplexes and sends a stream comprised of three types of information: audio, video and data. This stream is referred to as the transport stream and each sub-stream of a given information type contained within that stream are referred to as program elements.

Typically, an MPEG receiver has three paths along which the data is sent after de-multiplexing. One prior art example is shown in Figure 1. The decoder 10 receives the transport stream 12 to a demultiplexing stage 14. The demultiplexer handles the program elements and identifies to which path the individual packets inside the program element need to be sent. The identification is found in quantity referred to as the Packet Identifier or PID. For

example, demultiplexing stage 14 sends audio packets to a transport buffer 16 which in turn sends the buffered audio packets to a smoothing buffer 18.

Transport buffer 20 receives video packets and in turn send the buffered packets to a smoothing buffer 22. The smoothing buffer 22 sends the data to an elementary buffer 24. A similar path structure would be repeated for data packets with transport buffer 26, smoothing buffer 28 and elementary buffer 30. The functions and nature of the various buffers and their outputs can be seen with reference to Figure 2 and the video path structure.

Transport buffer 22 has a set size of 512 bytes. The design constraints imposed on MPEG systems require that this buffer cannot suffer from overflow. MPEG-2 program element packets have a predetermined size as well. The packets have 184 bytes of information, referred to as payload, and 4 bytes of header, for a total packet size of 188 bytes. Because of the restrictions on the transport buffer 20, this then governs the delivery schedule for the incoming packets between audio, video and data packets.

This constraint on scheduling is relaxed by the smoothing buffer 22. The smoothing buffer allows the system to control the output rate of the smoothing buffer to the elementary buffer 24. This is called the leak rate. Elementary buffer 24 reconstructs the data access units (DAU) of the initial information stream, and then passes these units to the receiver in the output device, in this case the video display.

The elementary buffer is emptied by removal of the packets at a time determined by an MPEG quantity called the presentation time stamp, or DTS.

The DTS is used as a time reference to sequence the data access units into the appropriate order to reconstruct the original information stream. The elementary buffer typically has only one output port, which can restrict the system performance. The Presentation Time Stamp (PTS) defines the instant in time with which the decoded data access unit is associated. In a streaming data elementary stream, the DTS can be inferred from the PTS of the previous DAU in the same stream.

Several proposals have been made to increase system performance. For example, methods to improve the performance of the multiplexing/demultiplexing based upon the PID can be found in US Patent Nos. 5,835,493, issued November 10, 1998, and 5,666,487, issued September 9, 1997. A method involving the multiplexing of the audio stream is shown in US Patent No. 5,875,007, issued February 23, 1999. Similarly, a method for multiplexing the application data for MPEG-2 packets is shown in US Patent No. 5,856,973, issued January 5, 1999. All of these approaches rely upon or use multiplexing at the PID level.

Secondary multiplexing within the decoder would increase system performance. One proposal suggests using a second multiplexing stage just prior to the elementary buffer. This has been referred to as FlexMux in the ISO/IEC JTC 1/SC 29 WG 11 on Information Technology – Coding of Audiovisual objects, part 12. However, current proposals rely upon additional information such as headers being sent within the packet payload to direct the

demultiplexing operation. This contributes to the system overhead, decreasing system performance and efficiency.

Therefore, a method is needed that allows secondary multiplexing to be performed in video stream decoders that does not require any additional information.

SUMMARY OF THE INVENTION

One aspect of the invention is a target system decoder that receives and processes information with a secondary multiplexing scheme. The decoder has a first demultiplexer that demultiplexes the incoming transport stream into packets and then passes the packets to at least one transport buffer. The transport buffers then pass the packets to a smoothing buffer that in turn passes the data to a second demultiplexer. The second demultiplexer demultiplexes data from within the packets into data access units that are passed to a corresponding data elementary buffer.

Another aspect of the invention includes a means for removing asynchronous data streams from the transport streams separate from the synchronous data handled by the second demultiplexer. The means for achieving this could be a third multiplexer or part of the functionality of the second demultiplexer.

BRIEF DESCRIPTION OF THE DRAWINGS

For a more complete understanding of the present invention and for further advantages thereof, reference is now made to the following Detailed Description taken in conjunction with the accompanying Drawings in which:

Figure 1 shows a block diagram representation of a prior art transport stream decoder.

Figure 2 shows a block diagram representation of a video packet decoding path as part of a transport stream decoder.

Figure 3 shows a block diagram representation one embodiment of a transport stream decoder with secondary multiplexing.

Figure 4 shows a detailed block diagram representation of one embodiment of a transport stream decoder with secondary multiplexing.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Figure 3 shows on embodiment of a transport stream decoder with a secondary multiplexing stage. As mentioned previously, the idea of using a secondary multiplexer was suggested as part of a proposed revision of the MPEG decoders referred to as FlexMux. However, the current FlexMux proposal involves adding more information within the MPEG packet payload to allow the secondary multiplexer to process the packet properly.

This approach has two major drawbacks. First, the functionality of decoding this extra information has to be included in the target decoder. Second, the additional information has to be provided at the transmission, or authoring end. Currently, neither one of these exists.

The present invention does not require this information, which eliminates the extra authoring on the transmission side. It does require a different structure of the target decoder, but the added structure is minimal compared to the proposed FlexMux structure.

It is helpful in the understanding of the invention to provide a basic overview of MPEG-2 and its associated terminology. In MPEG-2, the audiovisual information to be transmitted is encoded into elementary streams. Elementary streams are continuous streams of encoded data, with no systems information. The elementary streams may be audio or video. For discussion purposes, a video elementary stream will be used.

The elementary stream is then packetized into the packetized elementary stream (PES). PES packets can be of variable length and typically contain

elementary stream data and a PES header that gives information about those bytes including when the data should be decoded and displayed, referred to as the decode time stamp (DTS) and the presentation time stamp (PTS).

The PES packets are then further divided up into fixed length transport packets for the MPEG-2 transport stream. These packets are currently of 188 bytes, 184 bytes of payload data and 4 bytes of header information. Each transport packet has an identifier, called a PID (packet identifier). The PID contains all the navigation information required to find, identify and reconstruct programs. It is also associated with a stream_type value indicating the type of data conveyed in the elementary stream.

In addition to PES packets, an MPEG-2 transport stream includes sections of tables that transfer other systems information. For example, the program map table (PMT) identifies which PIDs go to which audiovisual events. Several transport packets may be have the same PID, the collection of which is referred to as a program element. A program element may be a video elementary stream, an audio elementary stream, a series of MPEG-2 table sections, etc.

Current receivers typically have limitations as to how many program elements they can acquire. Being able to pack elementary streams of the same type into one program element allows systems to transmit more information without requiring new receivers. The FlexMux approach, above, does not allow this type of packing without requiring implementation of new hardware/firmware.

One of the advantages of the present invention is that it does not require new hardware/firmware. It capitalizes on information already present in the MPEG-2 tables, mentioned above. The tables are broken down into sections, with a field that identifies the section number in the table called the section_number. The tables are used to packetize each data elementary stream into a sequence of data access units (DAU). The DAU is the payload of MPEG sections sharing the same table_id and table_id_extension field values. The data access units are then multiplexed into the same MPEG-2 program element.

The definitions of a typical MPEG section field values and sizes is shown in the following table:

Field Name	Description	Size (bits)
table_id	Identifies the content and format of the MPEG section payload, defines particular encoding rules for the table_id_extension	8
section_syntax_indicator	When set to '0' indicates the presence of a checksum field. It is set to '1' to signal the presence of a CRC_32 field.	1
section_length	This specifies the number of remaining bytes in the section immediately following this field up to the end of the MPEG section	12
table_id_extension	The semantics of this field is scoped by the value of the table_id field	16
version_number	Represents the version number of the MPEG section.	5
section_number	The number of the current MPEG section. Section numbers start with 0x00 and increments by one for each section	8
last_section number	This specifies the last section number for this particular MPEG table	8
checksum	Used for error detection and control, may not be used.	32
CRC_32	Contains the CRC value that gives a zero output after processing the entire MPEG section	32

Referring now to Figure 3, the operation of the invention can be seen. Transport packets containing the data from a given program element, as indicated by its PID, are passed to the transport buffer for that stream. As can be seen in Figure 3, the example shows the structures for streams 1 through n.

It must be noted that there can be more or less than n streams, and this is just for purposes of discussion. The structure and the method will be discussed relevant to stream 1.

Therefore, complete transport packets for stream 1 are passed from the primary multiplexer 14 to the transport buffer 20a for stream 1. All the bytes that enter the transport buffer 20a are removed at a predetermined rate. Bytes that are part of an MPEG section are delivered to the smoothing buffer(1) 22a. Other bytes that are not part of the MPEG section may be used to control the system.

Bytes associated with a synchronized data elementary stream are transferred to the corresponding data elementary buffer. For example, the data elementary stream for data elementary stream 1 in the MPEG program element 1 would go to data elementary buffer (DEB) (1,1) 24a. Only bytes associated with a DAU are transferred to the DEB. Some bytes may be header bytes or error control bytes. These are discarded.

For purposes of discussion only, specific table ids and extension values can be followed through the system. At demultiplexer 14, for example, packets with the same PID 0x0FDA will be sent to transport buffer 20a and smoothing buffer 22a. At second demultiplexer 23a, the table_id_extension values are used to identify the secondary channel on which a data elementary sub-stream is being conveyed, thereby allowing information from multiple sub-streams to be multiplexed into one MPEG-2 program element. For example, if the table_id is assumed to be 0x3C, the extension value 0xABCD may be sent to DEB(1,1),

and 0x9876 to DEB (1,2). This process may continue until the data for a table_id_extension corresponding the *kth* DEB for stream 1.

The invention can be extended to include other types of data than synchronized data for a given program element. As can be seen in Figure 4, a more detailed view of an alternative to the components contained in box 40 of Figure 3 is shown.

In this instance, the table_id is such that it does not correspond to the table_id for synchronized data, but is part of a table for asynchronous data. This asynchronous data is removed prior to or in conjunction with the secondary multiplexing. Figure 4, as an example, shows a third demultiplexer 25a that operates on the table_id field values. In implementation, however, this demultiplexing task could be performed by the same demultiplexer that performs the table_id_extension based demultiplexing. Alternatively, it could be performed by some other type of circuitry that has the capability of recognizing a certain table_id and switching data associated with that table_id to a different path.

In summary, then, the first demultiplexer assigns packets based upon the PID value, which identifies the MPEG-2 program element to which the packet belongs. This is the current state of the art in MPEG-2 receivers. The second multiplexer assigns packets based upon the table_id and table_id_extension, allowing multiple elementary streams within that program element to be transmitted. This solution allows multiple data elementary streams to be

multiplexed into an MPEG-2 program element in a realizable fashion, unlike the FlexMux proposal.

Thus, although there has been described to this point a particular embodiment for a method and structure for secondary multiplexing of MPEG-2 transport streams, it is not intended that such specific references be considered as limitations upon the scope of this invention except in-so-far as set forth in the following claims.

WHAT IS CLAIMED IS:

1. A system target decoder operable to receive and process information, comprising:
   a) a first demultiplexer operable to demultiplex a transport stream into packets each having a given packet identifier;
   b) at least two transport buffers operable to receive packets from the first demultiplexer, each said transport buffer receiving packets with the same packet identifier;
   c) a smoothing buffer, corresponding to one of the transport buffers, operable to receive packets from the transport buffer at a predetermined rate;
   d) a second demultiplexer operable to demultiplex data from within the packets from the smoothing buffer into data access unit data; and
   e) at least two data elementary buffers operable to receive the data access unit data from the second demultiplexer.
2. The decoder as claimed in claim 1, wherein the system further includes a third demultiplexer between the smoothing buffer and the second demultiplexer operable to demultiplex asynchronous data separate from synchronized data.
3. The decoder as claimed in claim 1, wherein the second demultiplexer also demultiplexes asynchronous data separate from synchronized data.
4. A method of demultiplexing data within a transport stream packet comprising the steps of:

a) receiving a transport stream at a first demultiplexer;

b) initially demultiplexing the transport stream into packets with a first demultiplexer using packet identifiers;

c) buffering the packets from the first demultiplexer in a transport buffer;

d) sending the packets from the transport buffer to a smoothing buffer;

e) transmitting the packets from the smoothing buffer to a second demultiplexer;

f) using information in the packet header identifying data access units to secondarily demultiplex data from within the packet; and

g) storing synchronized data access units reconstructed from secondarily demultiplexed data in a data elementary buffer.

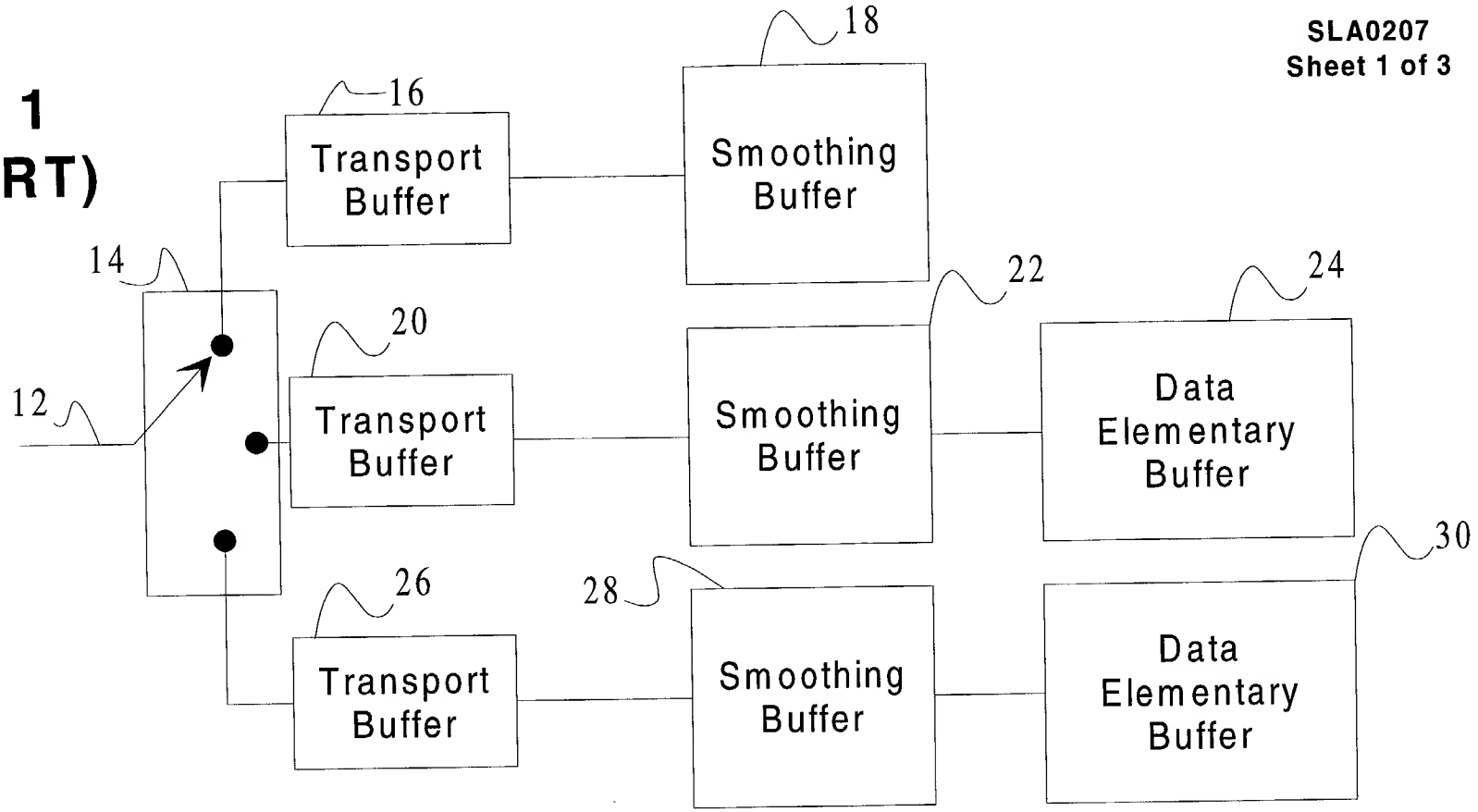
5. The method as claimed in claim 4, wherein the second demultiplexer also demultiplexes asynchronous data separate from synchronized data.

6. The method as claimed in claim 4, wherein the method includes the further step of demultiplexing asynchronous data separate from synchronized data between the transmitting and using steps.

ABSTRACT

A system target decoder operable to receive and process information. The system target decoder has a first demultiplexer that can demultiplex a transport stream into packets each having a given packet identifier. There are at least two transport buffers that can receive packets with the same packet identifier from the first demultiplexer. The transport buffers transfer the data to a smoothing buffer that in turn sends the data to a second demultiplexer. The second demultiplexer demultiplexes data from within the packets from the smoothing buffer into data access units.

**FIGURE 1
(PRIOR ART)**



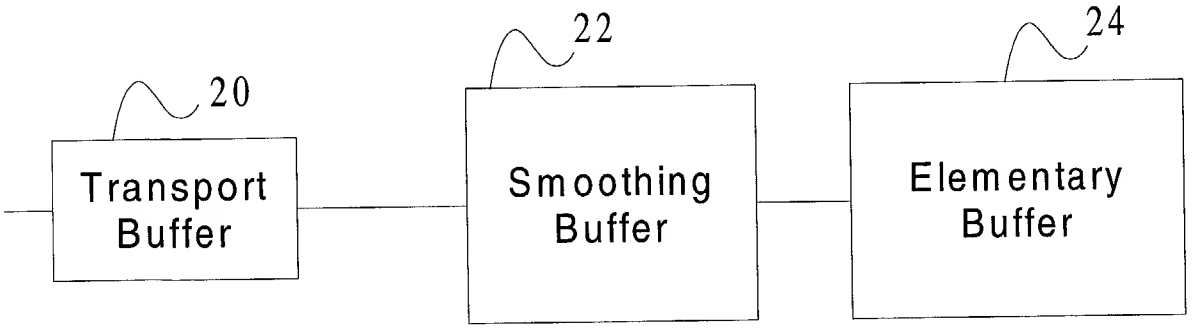


**FIGURE 2
(PRIOR ART)**

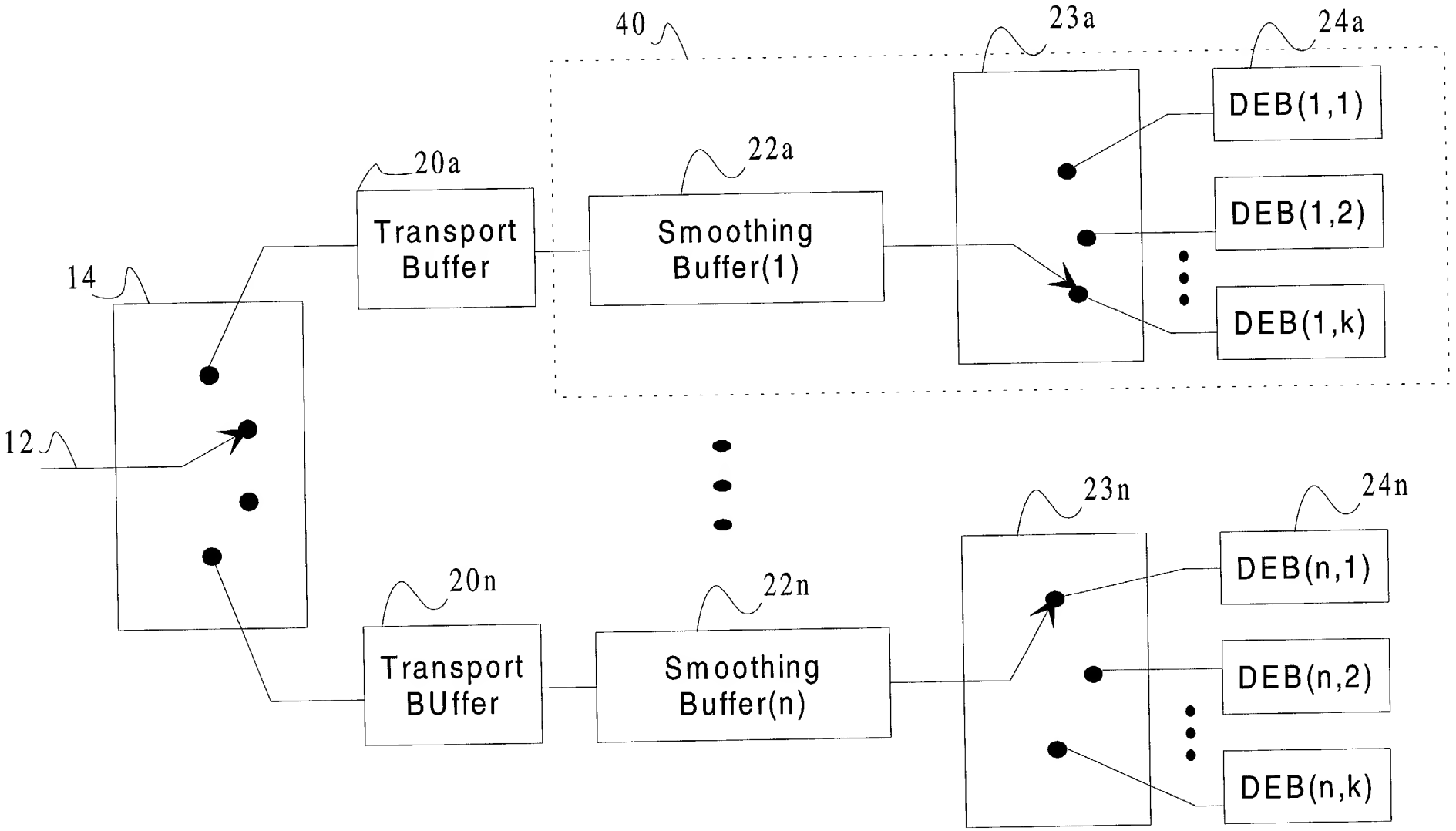

40
23a
24a
DEB(1,1)
22a
20a
Transport Buffer
Smoothing Buffer(1)
DEB(1,2)
14
DEB(1,k)
12
23n
24n
DEB(n,1)
20n
22n
Transport BUffer
Smoothing Buffer(n)
DEB(n,2)
DEB(n,k)

FIGURE 3

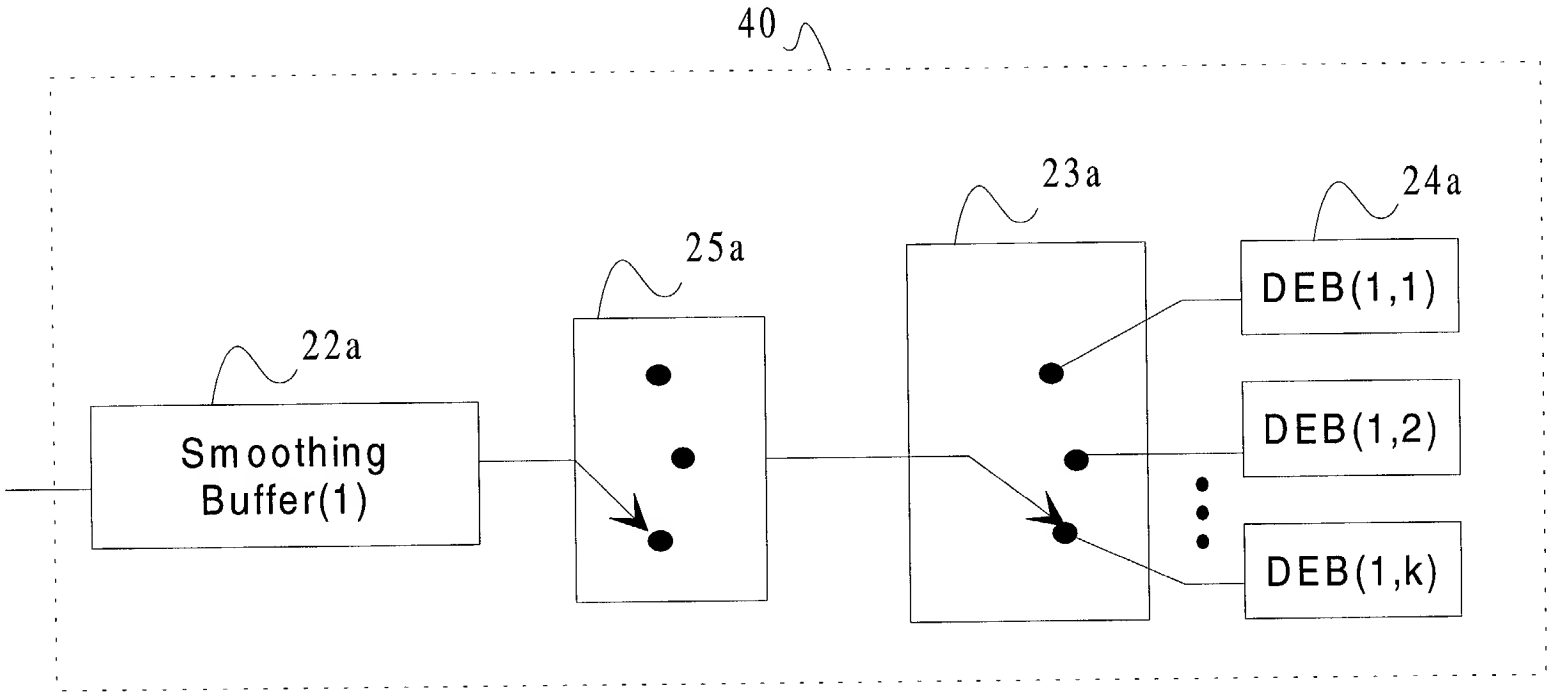


FIGURE 4

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Attorney Docket #:
SLA0207

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5750 NW Pacific Rim Blvd.
Camas, WA 98607

3) The nature of the conveyance is AN ASSIGNMENT, which was executed on February 23, 2000.

4) This document is being filed with a new patent application, for which the execution data of the application is February 23, 2000.

5) Any and all correspondence concerning this document should be addressed and mailed to the following:

Julie L. Reed, Esq.
Sharp Laboratories of America, Incorporated
5750 NW Pacific Rim Blvd.
Camas, WA 98607
(360) 817-7651

6) The total number of patent applications involved in this conveyance is: 1.

7) **Please charge any fees and credit any overcharges to Deposit Account 50-0803.**

8) To the best of my knowledge and belief, the foregoing information is true and correct and any attached copy is a true copy of the original document.

Respectfully submitted,

Julie L Reed

Julie L. Reed
Reg. No. 35,349
Sharp Laboratories of America, Incorporated
5750 NW Pacific Rim Blvd.
Camas, WA 98607

ATTORNEY DOCKET NO.
SLA0207

ASSIGNMENT

WHEREAS, I, the undersigned inventor (or each of the undersigned joint inventors), of residence as listed, having invented certain new and useful improvements as below entitled, for which application for United States Letters Patent is made, the said application having been executed on the date set forth below; and

WHEREAS, SHARP LABORATORIES OF AMERICA INCORPORATED, a corporation organized and existing under the laws of the State of Washington, with a place of business at 5750 NW Pacific Rim Blvd., Camas, WA, 98607, is desirous of acquiring my entire right, title and interest in and to the said invention, and to the said application and any Letters Patent that may issue thereon;

NOW, THEREFORE, for good and valuable consideration, the receipt of which is hereby acknowledged, I hereby sell and assign to the said SHARP LABORATORIES OF AMERICA INCORPORATED, its successors and assigns, my entire right, title and interest in and to the said invention and in and to the said application and all patents which may be granted therefor, and all divisions, reissues, substitutions, continuations, and extensions thereof; and I hereby authorize and request the Commissioner of Patents and Trademarks to issue all patents for said invention, or patent resulting therefrom, insofar as my interest is concerned, to the said SHARP LABORATORIES OF AMERICA INCORPORATED, as assignee of my entire right, title and interest.

I also hereby sell and assign to SHARP LABORATORIES OF AMERICA INCORPORATED, its successors and assigns, my foreign rights to the invention disclosed in said application, in all countries of the world, including the right to file applications and obtain patents under the terms of the International Convention for the Protection of Industrial Property, and of the European Patent Convention, and further agree to execute any and all patent applications, assignments, affidavits, and any other papers in connection therewith necessary to perfect such patent rights.

I hereby further agree that I will communicate to said SHARP LABORATORIES OF AMERICA INCORPORATED, or to its successors, assigns, and legal representatives, any facts known to me respecting said invention, and at the expense of said assignee company, testify in any legal proceedings, sign all lawful papers, execute all divisional, continuation, reissue and substitute applications, make all lawful oaths, and generally do everything possible to aid said SHARP LABORATORIES OF AMERICA INCORPORATED, its successors, assigns and nominees to obtain and enforce proper patent protection for said invention in all countries.

IN WITNESS WHEREOF, I hereunto set hand and seal this day and year;

TITLE OF INVENTION	**SYSTEM TARGET DECODER WITH SECONDARY MULTIPLEXING**		
SIGNATURE OF INVENTOR AND NAME	Regis J. Crinon **Regis J. Crinon**		
DATE	February 23, 2000		
RESIDENCE (City, County, State)	**Camas, Clark, WA**		
DATE APPLICATION EXECUTED	February 23, 2000		

After recording, return Assignment to:

Julie L. Reed, Esq.
SHARP LABORATORIES OF AMERICA Incorporated
5750 NW Pacific Rim Blvd.
Camas, WA 98607

ATTORNEY'S DOCKET NO.
SLA0207

APPLICATION FOR UNITED STATES PATENT DECLARATION AND POWER OF ATTORNEY

As a below named inventor, I declare that my residence, post office address and citizenship are as stated below next to my name; that I verily believe that I am the original, first and sole inventor if only one name is listed below, or an original, first and joint inventor if plural inventors are named below, of the subject matter which is claimed and for which a patent is sought on the invention entitled as set forth below, which is described in the attached specification; that I have reviewed and understand the contents of the specification, including the claims, as amended by any amendment specifically referred to in the oath or declaration; that no application for patent or inventor's certificate on this invention has been filed by me or my legal representatives or assigns in any country foreign to the United States of America; and that I acknowledge my duty to disclose information which is material to the patentability of this application in accordance with Title 37, Code of Federal Regulations, section 1.56;

I further declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true, and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

TITLE OF INVENTION: SYSTEM TARGET DECODER WITH SECONDARY MULTIPLEXING		
POWER OF ATTORNEY: I HEREBY APPOINT THE FOLLOWING ATTORNEYS TO PROSECUTE THIS APPLICATION AND TRANSACT ALL BUSINESS IN THE PATENT AND TRADEMARK OFFICE CONNECTED THEREWITH: Julie L. Reed, Registration No. 35,349		
SEND CORRESPONDENCE TO:	Julie L. Reed Sharp Labs of America 5750 NW Pacific Rim Blvd. Camas, WA 98607	**DIRECT TELEPHONE CALLS TO:**
NAME OF INVENTOR: (1) Regis J. Crinon	**NAME OF INVENTOR:** (2)	**NAME OF INVENTOR:** (3)
RESIDENCE & POST OFFICE ADDRESS: 2346 NW Cascade St. Camas, WA 98607	**RESIDENCE & POST OFFICE ADDRESS:**	**RESIDENCE & POST OFFICE ADDRESS:**
COUNTRY OF CITIZENSHIP: France	**COUNTRY OF CITIZENSHIP:**	**COUNTRY OF CITIZENSHIP:**
SIGNATURE OF INVENTOR: Regis J. Crinon	**SIGNATURE OF INVENTOR:**	**SIGNATURE OF INVENTOR:**
DATE: February 23, 2000	**DATE:**	**DATE:**